PHENOLOGY OF TROPICAL PINES[1]

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IN THE TEMPERATE ZONE pines shed their pollen during the season of the year vaguely designated as spring. At that time pollination occurs, and the ovulate strobili begin to develop slowly and, in warmer parts of the zone, continue to develop throughout the ensuing winter.[2] Ovules are fertilized the next spring, the cones develop throughout the second growing season, and the seeds ripen in the fall. Time elapsed between pollination and ripening of the seed thus is equal to about 15 or 16 months and embraces two summers and one winter. The farther south, the earlier pine pollen flies. Of course, many local environmental and genetic factors determine the time of pollen shedding. *Pinus radiata* D. Don sheds pollen in March both in its natural environment on the Pacific Coast and in low elevations of the Sierra Nevada. It is interesting that when *Pinus radiata* is planted in the southern hemisphere, for example, in New Zealand where it is known as *Pinus insignis* Douglas, it sheds pollen when it is spring there, i.e., during August or September.

It should be noted that photoperiod *sensu stricto* does not affect flowering of pines; they are photoperiodically neutral. That is, when a northern (long day) pine is moved to a more southern (shorter day) location, its flowering pattern is not changed. When a tropical (short day) pine is cultivated in a more northern (longer day) latitude, it continues to flower as freely as in its southern home.[3]

The closer to the Equator, the more distorted is flowering in pines. Even in the southern parts of the United States, pines, for instance *Pinus elliottii* Engelm. in southern Texas or in northern Florida, shed their pollen sometimes as early as the end of January. When you go farther south to the highlands of Mexico, early "flowering" of pines becomes a widespread phenomenon, and its relation to the four seasons of the year becomes really distorted.

I had occasion to observe *Pinus oocarpa* Schiede at the southernmost limits of pine distribution in Nicaragua. It was on a south slope of the mountains at an elevation of 4000 feet above sea level. It was the middle of February; the trees had just completed blooming (probably at the end of January), and numerous female strobili were still pink and tender, just having passed their "receptive stage." But the trees also possessed many full-sized cones, still green in color but already containing ripe seeds.

[1] Regarding definition of the term "tropical pines" see my paper on "Some taxonomic problems of tropical pines," Proceedings, 13th Congress of the International Union of Forest Research Organizations, Vienna, 1961. (In press.)

[2] Gifford, Ernest M. Jr., and N. T. Mirov. Initiation and ontogeny of the ovulate strobilus in ponderosa pine. Forest Sci. **6**: 19–25. 1960.

[3] Mirov, N. T. Photoperiod and flowering of pines. Forest Sci. **2**: 328–332. 1956.

Squirrels were busy cutting the cones and eating the fresh seeds. There it was evident that the timetable of events leading to the production of seeds was somewhat distorted.

Springtime in Nicaragua is not an upsurge of life as in the North; tropical pines never cease to grow. We cannot make the statement that in the mountains of Nicaragua it takes two growing seasons, or two calendar summers, for seeds to mature. The ovulate strobili continue to develop, apparently without much winter slowing, for there is no winter; and it takes them only a little over one year to mature. That is why a Honduran botanist told me once that in his country it takes only one year for *Pinus oocarpa* to produce seed.

In Indonesia, late in February and early in March of 1961, I observed even more distortion in the flowering of pines. The pine there was *Pinus merkusii* De Vriese, moved from the mountains of northern Sumatra (about 3° N. Lat.) to the mountains and lowlands of Java (about 6° S. Lat.). I am not familiar with the flowering habits of this pine in Sumatra, but I suspect, judging from its performance in the mountains of northern Thailand, that it sheds pollen in January.

In the mountains of Java (elev. 4900 ft.) near Bandung, *Pinus merkusii* sheds its pollen twice a year: in January–February, and in July–August. Better seeds are obtained from the latter pollination.

A 20-year-old pine plantation at sea level was visited February 25, 1961. The forest ranger procured phenological records taken for several years. These records showed that *Pinus merkusii* pollen had been produced and dispersed intermittently all year round; the ovulate strobili emerging from the buds, as well as the mature cones, were also recorded throughout the year. But *Pinus kasya* Royle, a pine of Burma and Indochina, growing naturally at elevations higher than those of *P. merkusii*, neither produced pollen nor developed ovulate strobili in the plantation. Apparently high air humidity is detrimental to the normal seed production of this pine in the humid and hot lowlands of Java.

These cursory observations suggest that a more comprehensive study of the phenology of tropical pines would be interesting and profitable. Both Central America and Indonesia are well suited to such a study. In Central America there are several institutions in Honduras, Nicaragua and Guatemala where such work could be done. In Sumatra, where the southernmost of all pines, *Pinus merkusii* grows naturally (about 2° south of the Equator) travel is at present hazardous; but in Java there are many easily accessible pine plantations where phenological records have been diligently kept. There a phenological project could be conducted either in the world renowned Herbarium Bogoriense, in Bogor, where the Forest Research Institute is also located, or in the Division of Biology of the Institute of Technology at Bandung.

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